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THE ADVANCE IN OUR KNOWLEDGE OF THE CAUSATION AND METHODS OF PREVENTION OF STOCK DISEASES IN SOUTH AFRICA DURING THE LAST TEN YEARS.[1]

I.

TEN years ago, when I first came to South Africa, I was led to take an interest in the various great stock diseases which do so much damage and so retard the progress of South Africa as a stock-raising country. I thought, therefore, that a good subject for my address, in the center of the foremost stock-raising colony of South Africa, would be a review of the work done in advancing our knowledge, during the last ten years, of the causation and methods of prevention of stock diseases in South Africa.

South Africa is particularly rich in animal diseases, every species of domestic animal seemingly having one or more specially adapted for its destruction. Now it is evident that, in an address of this kind, it will be impossible to take up every stock disease, but I think you will agree with me that those shown on this table are among the most important: East coast fever; ordinary redwater or Texas fever; biliary fever of horses; malignant jaundice of dogs; nagana or tsetse-fly disease; trypanosomiasis of cattle; rinderpest; horse-sickness; catarrhal fever in sheep; heart-water of sheep, goats and cattle.

Now we may group these diseases in vari-

[1] Address of the president of the Physiological Section of the British Association for the Advancement of Science, South Africa, 1905.

ous ways; for example, as below, where they are divided into two main divisions: *A* division, in which the parasite is known; and *B* division, in which the parasite is unknown.

A. PARASITE KNOWN.

I. Diseases caused by parasites belonging to the genus *Piroplasma:* (1) East coast fever (Koch), *P. parvum;* (2) Redwater or Texas fever, *P. bigeminum* (Theiler); (3) Biliary fever of horses, mules and donkeys, *P. equi;* (4) Malignant jaundice of dogs, *P. canis.*

II. Diseases caused by parasites belonging to the genus *Trypanosome:* (1) Nagana or tsetse-fly disease, *T. brucei* (Bradford and Plimmer); (2) Trypanosomiasis of cattle, *T. theileri* (Bruce).

B. PARASITE UNKNOWN.

I. Rinderpest.

II. Horse-sickness. Catarrhal fever of sheep; heart-water of sheep, goats and cattle.

I. DISEASES CAUSED BY PARASITES BELONGING TO THE GENUS PIROPLASMA.

1. *East Coast Fever.*

The first important stock disease I would draw your attention to, then, is east coast fever. This name was given to it by Professor Robert Koch, of Berlin. In the Transvaal the disease is usually called Rhodesian redwater. This term is not a good one, since the disease is not restricted to Rhodesia, nor did it arise there, nor is this a disease similar to the ordinary redwater. Ten years ago, when I first came to South Africa, east coast fever was unknown in the Transvaal. The first known outbreak occurred only some three and a half years ago, when it broke out at Koomati and Neilspruit, in the Barberton district, and in the east of the colony. The disease had broken out some time previously in Rhodesia, and the outbreaks in both colonies were due to infection from Portuguese territory. Although this disease has only been introduced to the country during the last few years, it has already produced an enormous amount of damage among stock, and is probably the most dangerous disease that the people of the Transvaal have to cope with at the present time, and for some years to come.

In the Annual Report of the Transvaal Department of Agriculture there is a most excellent report by Mr. Stockman, the then principal veterinary surgeon, on the work of the veterinary division for the year 1903–1904. A large part of this report is given up to east coast fever, and I must here express my indebtedness to Mr. Stockman for much of the following account of this disease. In the same annual report there is also an account by Dr. Theiler, the veterinary bacteriologist, of the experimental work. Messrs. Stockman and Theiler evidently worked together, and I must congratulate them on the immense amount of good, useful work done by them, and I would also congratulate the government on having had the services of two such accomplished and energetic gentlemen during the late troublesome times. Unfortunately for the Transvaal, Mr. Stockman has accepted the post of veterinary adviser to the board of agriculture in England, but I have no doubt his successor, Mr. Gray, from Rhodesia, will continue the good work begun by him.

East coast fever was first studied by Professor Koch at Dar-el-Salaam, in German East Africa, and he at first mistook it for ordinary redwater. It seems to occur as an endemic disease along a great part of the east coast of Africa, but appears to be restricted to a narrow belt along this coastline. The cattle inhabiting this region have become immune to the disease, and are, therefore, not affected by it. Cattle passing through the coast district to the interior, or brought to the coast district from the interior, are apt to take the disease and die. It was by the importation of cattle, therefore, which had passed through the

dangerous coast district that the disease was introduced into Rhodesia and into the Transvaal. On this map which I throw on the screen I have marked out the probable endemic area of this disease, and in the next slide the present distribution of the disease in the Transvaal is also marked out.

Nature of the Disease.—This disease only attacks cattle, but in them is an exceedingly fatal malady; in every hundred cattle attacked only about five recover from the disease. The duration of the disease after the first symptoms have occurred is about ten days.

The cause of the disease is a minute blood parasite called the *Piroplasma parvum* (Theiler). This parasite lives in the interior of the red blood corpuscles.

I now throw on the screen a representation of the blood from a case of Rhodesian redwater, magnified about a thousand times, showing these small piroplasmata in the interior of the red blood corpuscles. As in the case of so many of these blood diseases, the parasite causing it is carried from the sick to the healthy by means of a blood-sucking parasite. In this particular disease the tick which most commonly transfers the poison or living parasite from one animal to another is known as the 'brown tick,' *Rhipicephalus appendiculatus.* Koch supposed that the common 'blue tick' was the agent. The credit belongs to Dr. Lounsbury and Dr. Theiler of having shown that it is chiefly the 'brown tick' which acts as carrier; but Theiler has proved that *R. simus* is also able to transmit the disease. Without the intervention of a tick, as far as we know at present, it is quite impossible that the parasite of this disease can be transferred from one animal to another. For example, if we take a quantity of blood containing enormous numbers of these piroplasmata, and inject it into the blood circulation of a healthy animal, the latter does not take the disease. In the same way, if cattle affected by east coast fever are placed among healthy cattle in a part of the country where none of these 'brown ticks' are found, the disease does not spread. It is evident, therefore, that some metamorphosis of the parasite must take place in the interior of the tick, and this new form of the parasite is introduced by the tick into a healthy animal, and so produces the disease. In this particular disease the virus or infective agent is not transmitted through the egg of the tick, as is the case in some of these parasitic diseases, but only in the intermediate stages of the tick's development; that is to say, the larva which emerges from the egg of the tick is incapable of giving the disease. What happens is this: the larva creeps on to an infected animal and sucks some of its blood. It then drops off, lies among the roots of the grass, and passes through its first moult. The nympha, which is the name given to the creature after its first moult, is capable of transferring the disease to a healthy animal; that is to say, if it crawls on to a healthy animal and sucks blood from it, it at the same time infects this healthy animal with the germ of east coast fever. In the same way, if a nympha sucks infected blood from a sick animal, it is able, after it has moulted into the adult stage or imago, again to give rise to the disease if placed, or if it crawls, upon a healthy animal.

The Life-history of the Brown Tick.—I throw on the screen a slide representing the four stages of the life-history of the brown tick: The egg, the larva, the nympha and the adult or imago. The eggs are laid on the surface of the ground by the adult females, who deposit several thousand at a time; and these hatch out naturally, if the weather is warm and damp, in twenty-eight days. But this period of incubation of the

eggs may vary very greatly owing to differences in temperature. Immediately after the larva is born it crawls to the summit of a blade of grass or grass stem, and there awaits the passage of some animal. If an ox passes by and grazes on the grass, the tick at once crawls on to the animal, and, having secured a favorable position, starts to suck the ox's blood. It remains on the ox for some three or more days, when, having filled itself with blood, it drops off and lies among the grass. The first moult, under favorable conditions, takes twenty-one days, when the nympha emerges. In the same way the nympha crawls on to an animal and fills itself with blood. As a nympha it also remains on the animal for about three or four days. It again drops off into the grass, and at the end of eighteen days emerges from its second moult as the perfect adult male or female. The males and females again crawl on to an ox, where they mate. After this the female tick ingests a large quantity of blood, which is meant for the nourishment of the eggs, and again drops off, sometimes as early as the fourth day, into the surrounding grass. After about six days she lays her eggs in the ground, and the cycle begins again.

These ticks are very hardy, and in the intermediate stages can resist starvation for long periods, so that a larva or nympha or adult tick may remain perched at the end of a blade of grass for some months without finding an opportunity of transferring itself to a suitable animal. On this account it comes about that even if all infected cattle are removed from a field the ticks in that field will remain capable of transferring the infection to any healthy cattle which may be allowed into this field for a period of about a year. At the end of a year or fifteen months, however, the infective ticks are all dead, and clean cattle may be allowed into the field without any risk. If one takes these facts into consideration it will be seen that a single ox may spread this disease for a distance of some 200 miles, if trekking through the country at the average rate of ten miles a day. For example, an ox is infected by a tick; for fourteen days the animal remains apparently perfectly well; it has no signs of disease, nor has it any fever. It is capable of doing its ten miles' trek a day. At the end of fourteen days the temperature begins to rise, and the animal begins to sicken with the disease, but for the next six days the ox is, as a rule, able to do its ordinary day's march. During most of this time the brown ticks have been crawling on to this ox, becoming infected, and dropping off every three or four days. It can readily, therefore, be seen how much mischief a single infected animal can do to a country between the time of its being infected by the tick and its death some twenty-four days later. As a matter of experience, however, the disease has never been found to make a jump in this way of more than fifty or sixty miles, as, of course, it is very rare that a transport carrier will take his oxen more than that distance during the twenty days.

At the present time it may be said that there are about 500 infected farms in the Transvaal. During last year some 15,000 cattle died of the disease, and in the affected districts it may be said that there are still some 30,000 cattle alive. When one considers the value of the cattle dead of this disease, which may be said to be about £200,000, it is evident that money spent on the scientific investigation of the causes and prevention of stock diseases is money well spent. I am informed that all the South African governments are cutting down their estimates this year, and are inclined to reduce their veterinary staffs and the amounts devoted to research regarding

animal diseases. Ladies and gentlemen, if this is so, I have no hesitation in saying that this is the maddest sort of economy and the shortest-sighted of policies.

Methods of Combating the Disease.—During the last three years an immense amount of work has been done in the elucidation of this disease—how the animals are infected, how the poison is spread from the sick to the healthy, and so on. In 1903 Professor Koch was asked by the South African colonies to study this disease, in order to try to find some method of artificial inoculation or some other means of prevention. He did his work in Rhodesia, and especially directed his energies towards discovering some method of preventive inoculation. At first it was thought that he would be successful in this quest, as in his second report he announced that he had succeeded in producing a modified form of the disease by direct inoculation with the blood of sick and recovered animals. As you are all aware, the only method of conferring a useful immunity upon an animal is to make it pass through an attack of the disease itself, so modified as not to give rise to above a few deaths in every hundred inoculated. This is the method that has been employed in such diseases as rinderpest, anthrax, pleuro-pneumonia and many other diseases. The great difficulty in this disease in finding a method of preventive inoculation is the fact that the blood of an affected animal does not give rise to the disease in a healthy one when directly transferred under the skin of the latter. It is only after its passage through the body of the tick that the parasite is able to give rise to the disease in a healthy animal. It is evidently, on the face of it, difficult to so modify the parasite during its sojourn in the tick's body as to reduce its virulence to a sufficient degree.

Professor Koch in his third and fourth reports recommended that cattle should be immunized by weekly or fortnightly inoculations of blood from recovered animals, extending over a period of five months. Even though this method of Koch had given the desired result, viz., that it rendered the inoculated cattle immune to the disease, it is evident that the method itself can hardly be made a practicable one on a large scale in the field. The expense and trouble of inoculating cattle on twenty different occasions would be very great. It is apparent now that Professor Koch fell into error through mixing up east coast fever with ordinary redwater. His plan of preventive inoculation was, however, tried on a large scale in Rhodesia by Mr. Gray, now the principal veterinary surgeon, Transvaal, and found to be useless. At present, therefore, we must look to some other means of preventing the disease and driving it out of the country than preventive inoculation.

Dipping.—Much can be done to prevent the spread of this disease by ordinary methods. For example, in the case of Texas fever in Queensland dipping cattle in solutions of arsenic or paraffin, in order to destroy the ticks, has met with very fair success; but in the case of this disease we can not expect to get as good results as in the case of redwater. The species of tick which conveys Texas fever remains on the same animal through all its moults, instead of falling to the ground between each different one. If it is not possible to spray or dip cattle oftener than once in ten or fifteen days, it is evident that ticks may crawl upon such animals, become infected, and drop off every three or four days, and so escape destruction by the dipping solution. At the same time every infected tick that is killed by spraying or dipping operations is a source of infection destroyed.

Fencing of Farms.—Again, the fencing

of farms must also be useful in the same direction. As the ticks do not travel to any extent when they fall among the grass, it is evident that the cattle on a clean farm which is properly fenced will not become infected by this disease, although all the country round about should be infected. This fencing of farms and subdividing the farm itself into several portions is a most important factor in the prevention of contagious diseases amongst stock. It is, of course, impossible that this can be done at once, as the expense would be prohibitive.

Moving Cattle from Infected Pasture to Clean Pasture.—From a study of this disease and a study of the life-history of the tick it is evident that by a combination of dipping or spraying the cattle so as to destroy almost all the ticks, slaughtering the sick, and moving the apparently healthy on to clean veld—and repeating this, if necessary, a second or third time—it is obvious that by these means, if circumstances are favorable, an outbreak of this disease may be nipped in the bud without much loss to the stock.

Stamping out the Disease.—In May, 1904, an inter-colonial conference held at Cape Town resolved that the only effective method of eradicating east coast fever is to kill off all the cattle in the infected areas, and to leave such areas free of cattle for some eighteen months. By this means all the centers of infection would be destroyed, and at the end of eighteen months, as all the infected ticks would be dead, it is evident that the disease would be completely stamped out. There is no doubt that this drastic method would be the quickest and most complete one of getting rid of this extremely harassing disease. If compensation were given, it could be done at a cost of, say, a quarter of a million. The government decided, however, that on account of the difficulty of carrying out such a drastic scheme another policy had to be considered. This policy provides for the fencing-in of infected farms, places, lands or roads, on generous terms; the compulsory slaughter of stock with compensation in the case of isolated outbreaks; the removal of all oxen from infected or suspected farms; and, lastly, the stabling of milch cows in infected areas. It is quite evident that under this less drastic policy the final stamping-out of the disease will be a much slower process than if the more drastic scheme of compulsory slaughter of all cattle on infected areas had been carried out. The benefits, however, from the modified scheme are undoubted; and if carried out thoroughly and intelligently for a period of several years will probably result in the stamping-out of the disease.

Allow me to sum up in regard to the advance in our knowledge of this important stock disease during the last ten years. Ten years ago nothing was known. Now the causation of the disease has been made out very fully; the parasite that causes it is known; the ticks which carry the infection are known. Although no method of conferring immunity on healthy cattle has been found out, or any medicinal treatment discovered which will cure the sick animal, yet our knowledge of the life-history of the parasite and the tick enables regulations to be framed which, if patiently carried out, must be crowned with success.

2. *Redwater or Texas Fever.*

I may dismiss this disease in a few words. It is a most interesting disease and of great importance to stock farmers. It only affects cattle.

Geographical Distribution.—It is a disease found in almost every part of the world. It was first studied in North America; hence the name Texas fever. To Kilborne and Smith is due the honor of elu-

cidating the causation of this disease, and their work forms one of the most interesting chapters in the history of pathological science. They discovered that it was caused by the presence in the red blood corpuscles of a protozoal parasite closely related to the parasite found in east coast fever—the *Piroplasma parvum*. This organism is called *Piroplasma bigeminum*. They further discovered that this parasite was conveyed from sick to healthy cattle by means of a tick. They also showed that the cattle born and bred in certain southern districts are immune to the disease, whereas cattle in the northern districts are susceptible. Hence, if southern cattle were driven into the northern district, they gave rise to a fatal disease among the northern cattle; and, *vice versa*, if the susceptible northern cattle were driven into the southern district among the apparently healthy cattle of that district, they took Texas fever and died.

Texas fever was introduced about 1870, and is now endemic throughout most of South Africa. For many years the native cattle have been immune to the disease; that is to say, on account of being born and bred in a Texas fever locality they had inherited a degree of resistance to the disease which enabled them to pass through an attack when they were young, and so they became immune. But there is one peculiarity about Texas fever which does not occur in Rhodesian tick fever, and that is that the blood of an animal which has recovered from Texas fever remains infective—the germs remain latent—and so the native cattle of South Africa, although apparently healthy, are capable of infecting imported susceptible cattle with this very fatal malady. This is what makes it so difficult to import prize stock into this country.

When the Boers visited Mooi River, at the beginning of the war, they found a prize short-horn carefully stabled in Mr. P. D. Simmon's farm. They killed most of his stock for food, but left this short-horn bull alive. When they left the farm they turned this bull into the nearest field, in order, of course, that it might procure food. They had much better have eaten it. It promptly took Texas fever and died.

This disease, then, has become of secondary importance to South Africa in these days. The native cattle have become naturally immune, and the disease is only fatal to susceptible imported cattle. This, of course, discourages the importation of prize stock; but with the knowledge we possess it ought to be possible, by good stabling and prevention of contact with tick-infected cattle, to keep the prize stock alive for a reasonable time. The question of the feasibility of immunizing the prize stock while calves in England might be considered.

In regard to methods of conferring immunity on susceptible cattle many have been tried, but none are absolutely free from risk.

We may sum up in regard to redwater or Texas fever by saying that our knowledge of its causation and methods of prevention is much the same as it was ten years ago. The work done by Smith and Kilborne on this disease was of such a brilliant nature, and was done so thoroughly, that little has been left for later workers to do.

3. *Biliary Fever of Horses, Mules and Donkeys.*

This is a disease of horses, mules and donkeys very similar to redwater in cattle, and is caused by a closely allied parasite, the *Piroplasma equi*, discovered for the first time in South Africa by Bordet, Danysz and Theiler, and named by Laveran, of Paris.

It is similar to redwater, in that animals which have recovered from the disease re-

main a source of infection during the remainder of their lives to susceptible animals. The native South African horse is, like the cattle, immune to the disease. It is also conveyed by a tick, which has been shown by Theiler to be the 'red tick' (*Rhipicephalus evertsi*), the infection being taken in the nymphal and transferred in the adult stage. Theiler has also made the very important observation that if a horse is injected with blood from a donkey which has recovered from the disease, as a rule a mild form of the disease is produced, so that this opens up a method of immunizing susceptible horses which may probably prove of practical value. Theiler has also made another curious discovery. This disease of horses was found to greatly complicate certain immunizing experiments he was making against horse-sickness. He found he was introducing the *Piroplasma equi* at the same time he injected horse-sickness virus. But he found out that as the virus of horse-sickness keeps its virulence for years, whilst the *Piroplasma equi* dies out in a short time, this danger could be avoided by keeping the horse-sickness serum and virus for some time before using it.

4. *Malignant Jaundice of Dogs.*

This disease is most important to sportsmen or to importers of valuable dogs, as most of these are attacked sooner or later by this disease, and most of them succumb. It is also caused by a species of *Piroplasma* (*Piroplasma canis*), and is spread by the dog tick (*Hæmophysalis leachii*).

Like redwater and biliary fever, the blood of dogs which have recovered remains infective.

The story of the tick infection is a curious one, and the credit of its discovery is due to Lounsbury. It is only in the adult stage that the tick is capable of producing the disease. It is, therefore, evident that the *Piroplasma* must remain latent in the egg, the larval and nymphal stages, and only attain activity in the adult stage.

According to Theiler there exists a peculiar phenomenon which may be made use of to confer immunity. The blood of a dog which has recovered from this disease and has been hyper-immunized is, as mentioned above, capable of giving rise to the disease in a susceptible dog. Now, if serum be obtained from this blood and a quantity added to a small amount of the blood, this infected blood loses its infectivity and no disease results.

II. DISEASES CAUSED BY PARASITES BELONGING TO THE GENUS TRYPANOSOME.

1. *Nagana or Tsetse-fly Disease.*

We now come to the second group of diseases. These are also caused by blood parasites belonging to the same class of living things as the *Piroplasma,* but which are free organisms, swimming in the fluid part of the blood, and not contained in the red blood corpuscles, as are the others.

The first of this group I would draw your attention to is that disease called nagana or the tsetse-fly disease.

This fly renders thousands of square miles of Africa uninhabitable. No horses, cattle, nor dogs can venture, even for a day, into the so-called 'fly country.' Now what was our knowledge of this disease ten years ago? At that time it was thought that the tsetse-fly killed animals by injecting a poison into them, in the same way as a snake kills its prey. Nothing was known as to the nature of this poison in 1894. In 1895, on account of serious losses among the native cattle in Zululand from this plague, the then governor of Natal and Zululand, Sir Walter Hely-Hutchinson, started the investigation of this disease. The result of this investigation was the discovery that tsetse-fly disease was not caused by a simple poison elaborated by the fly, as formerly

believed, but that the cause of the disease was a minute blood parasite which gained entrance to the blood of the animals. This parasite is known by the name *Trypanosoma,* which signifies a screw-like body.

Ten years ago two species only had attracted much attention—one living in the blood of healthy rats, discovered by Surgeon-Major Lewis in India; and the other, a trypanosome, found in the blood of horses and mules suffering from a disease known in India as 'surra.' As the result of this investigation in Zululand, which lasted two years, it was proved that this trypanosome was undoubtedly the cause of the death of the horses and cattle struck by the fly, and that the tsetse-fly merely acted as a carrier of this blood parasite.

Here is a representation of the trypanosome of nagana on the screen. These trypanosomes consist of a single cell; are sinuous, worm-like creatures, provided with a macronucleus and micronucleus, a long terminal flagellum, and a narrow fin-like membrane continuous with the flagellum and running the whole length of the body. When alive they are extremely rapid in their movements, constantly dashing about, and lashing the red blood corpuscles into motion with their flagellum. They swim equally well with either extremity in front. These organisms multiply in the blood by simple longitudinal division, and often become so numerous as to number several millions in every drop of blood. They are sucked, along with the blood, into the stomach of the fly, live and multiply in the alimentary tract for several days, and, when the fly has its next feed on an animal, take the opportunity of gaining access to the blood of the new host, and so set up the disease.

Let me now throw on the screen a representation of the tsetse-fly (*Glossina morsitans*) which does all the mischief. Experiments were made which showed that the fly could convey the parasite from affected to healthy animals for at least forty-eight hours. It is a curious fact that among all the blood-sucking flies the tsetse fly alone has this power, and up to the present the cause of this has not been thoroughly cleared up. Lately, however, evidence has been brought forward to show that an enormous multiplication and development of the trypanosomes take place in the fly's intestine, a few trypanosomes multiplying to masses containing numberless parasites within twenty-four hours. Now, if this multiplication only takes place in the intestine of the tsetse-fly, and not in the other kinds of biting flies, this would probably account for the curious connection between the tsetse-fly and the disease. This multiplication of the trypanosomes in the tsetse-fly was discovered by Gray and Tulloch, two young army medical officers, while working in Uganda on 'sleeping sickness' during the present year.

Not only was it found that the tsetse-flies could convey the disease from sick to healthy animals, but it was also proved that the wild tsetse-flies brought from the 'fly country' and straightway placed on healthy animals also gave rise to the disease. The question then arose as to where the tsetse-flies living in the 'fly country' came by the trypanosomes. There were no sick horses or cattle in the 'fly country.' Investigation brought to light the curious fact that most of the wild animals—the buffalo, the koodoo, the wildebeeste—carried the trypanosomes in small numbers in their blood, and it was from them that the fly obtained the parasite. The wild animals act as a reservoir of the disease. The trypanosome seems to live in the blood of the wild animals without doing them any harm, just as the rat trypanosome lives in the blood of healthy rats; but when introduced into the

blood of such domestic animals as the horse, the dog or ox it gives rise to a rapidly fatal disease. The discovery that the wild animals act as a reservoir of the disease accounted for the curious fact that tsetse-fly disease disappears from a tract of country as soon as the wild animals are killed off or driven away.

In 1895 the living trypanosome which causes the tsetse-fly disease was sent to England in the blood of living dogs, in order that it might be studied in the English laboratories. These trypanosomes have been kept alive ever since by passage from animal to animal, and have been sent all over Europe and America, so that our knowledge of this kind of blood parasite has rapidly grown.

Koch, in a recent address, says that our knowledge of protozoäl diseases is based on three great discoveries—that of the malarial parasite, by Laveran; of the *Piroplasma bigeminum,* the cause of Texas fever or redwater in cattle, by Smith; and, lastly, this discovery of a trypanosome in tsetse-fly disease.

We may, therefore, I think, congratulate ourselves on the growth of our knowledge of this great stock disease during the last ten years.

Since 1895 many other trypanosome diseases have been discovered in all parts of the world. The latest and most important of these is one which affects human beings, and is known as 'sleeping sickness.' This 'sleeping sickness,' which occurs on the West Coast of Africa, particularly in the basin of the Congo, has within the last few years spread eastward into Uganda, has already swept off some hundreds of thousands of victims, is spreading down the Nile, has spread all round the shores of Lake Victoria, and is still spreading southward round Lakes Albert and Albert Edward. This disease is in all respects similar to the nagana or tsetse-fly disease of South Africa, except that it is caused by another species of trypanosome and carried from the sick to the healthy by means of another species of tsetse-fly, viz., the *Glossina palpalis.*

I now throw on the screen a map of Africa, showing, as far as is known up to the present, the various fly districts, and you will see from this map that it is not at all improbable that this human tsetse-fly disease may spread southward through the various fly districts to the Zambesi, and may even penetrate as far as the fly districts of the Transvaal and Zululand.

I am sorry to say that, in spite of innumerable experiments directed towards the discovery of some method of vaccination or inoculation against these trypanosome diseases, nothing definite, up to the present time, has been discovered. At present there does not seem to be any likelihood that a serum can be prepared which will render animals immune to the tsetse-fly disease. In the same way it has also been found impossible, up to the present, to so modify the virulence of the trypanosome as to give rise to a modified, non-fatal form of the disease. Again, all attempts at discovering a medicine or drug which will have the power of killing off the parasites within the animal organism, without at the same time killing the animal itself, have not as yet been successful, although some drugs, such as arsenic and certain aniline dyes (Ehrlich), have a very marked effect in prolonging the life of the animal. As this disease is fatal to almost every domestic animal it attacks, it seems very improbable that there is much chance of cultivating an immune race of horses, dogs or cattle which will be able to withstand the action of the parasite. It is quite evident that if an acquired immunity of this kind could be brought about, such a race of immune animals would now be found; but, as a matter

of fact, there are no horses, dogs or cattle in the 'fly country.' In other protozoal diseases, such as the *Piroplasmata,* this acquired immunity seems to come about fairly readily.

To sum up, then, the increase in our knowledge of tsetse-fly disease during the last ten years, we may say that we have discovered the cause in the shape of the small blood parasite *Trypanosoma:* we have found that the reservoir of the disease exists in the wild animals, and that we can blot out this disease from any particular tract of country by the simple expedient of destroying or driving away the wild animals. We still have no means of preventive inoculation or successful medicinal treatment in this disease.

2. *Trypanosomiasis of Cattle.*

This disease seems to be widespread over all South Africa. It can not be said to be of much practical importance, as the cattle infected do not seem to be seriously affected by it. It is caused by a species of trypanosome remarkable for its large size, which was discovered by Dr. Theiler some years ago, and named *T. theileri.*

Dr. Theiler states that it is conveyed from animal to animal by the common horse-fly, *Hippabosca rufipes.*

This, then, is a short account of the trypanosome diseases which affect South Africa.

Of late years the tsetse-fly disease has become of less practical importance to the Transvaal, from which it has practically disappeared. This is due to the disappearance of the game, killed off by rinderpest; but with the preservation and restoration of the reserves with big game the disease is certain to reappear. Why the fly should disappear with the game is not known.

D. BRUCE.

(*To be continued.*)

EUROPEAN AND AMERICAN SCIENCE.

ONE of the important accomplishments, doubtless, of the International Congress of Arts and Science held in connection with the exposition at St. Louis was, simply, the bringing to this country of a large number of learned men from other nations. Some of these men had visited America before, but many of them crossed the Atlantic last autumn for the first time and viewed Americans and American institutions with, as it were, a virgin sense. A number of those who made the trip have recorded their impressions in addresses or journal-articles. It would be a worthy task, should these increase in number, to collect and to publish them together, for aside from the gratification of the curiosity of seeing ourselves as others see us, it could scarcely fail to be instructive for us to study the observations and comments of men of the high type of those who were invited to the congress.

Of the foreign scientists who attended the St. Louis meeting and have given public expression to their ideas of America, one of the most distinguished and discerning is the professor of anatomy in the University of Berlin. It was not Professor Waldeyer's first visit to America; fond of travel and widely-travelled as he is, it was not for a man such as he to have left so long America unvisited. Moreover, an omnivorous reader, Waldeyer is more or less familiar with American literature; he numbers, too, among his friends many American scientists and literary men; indeed, many young biologists and anatomists from America have, in part at least, received their training in his laboratory. By personal observation, by correspondence, by reading and by multiple contact with educated Americans, Professor Waldeyer has had, more than most foreigners, opportunities for familiarizing himself with American science and American thought.